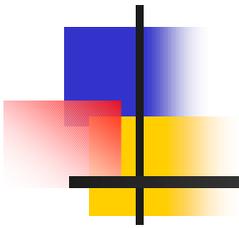
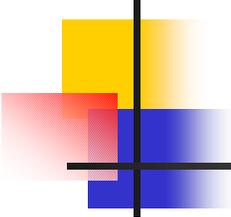


# LQ search in $e\nu\bar{\nu}j$ channel



Simona Rolli ( TUFTS)

-Status Report-



# Introduction

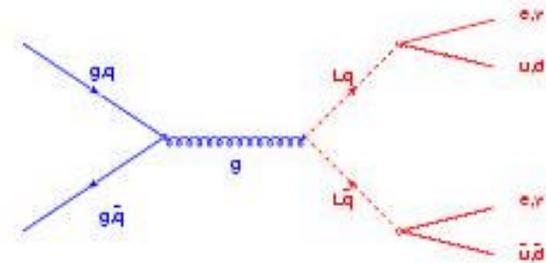
---

- Some beyond the SM models assume additional symmetry between leptons and quarks
- LeptoQuarks – transition between leptons and quarks
  - Have both lepton and baryon numbers
  - $\lambda$  - unknown coupling to leptons and quarks

# LQ production at the TeVatron

## ■ Production

- $qg \rightarrow LQ + LQbar$
- $gg \rightarrow LQ + LQbar$
- $q\bar{q} \rightarrow LQ + LQbar$



## ■ Decay

- $LQLQ \rightarrow l^+l^-qq, l^\pm nqq, nnqq$       $\beta = Br(LQ \rightarrow eq)$

## ■ Experimental signature:

- High  $pt$  isolated leptons (and/or MET) + jets

# LQ production at TeVatron

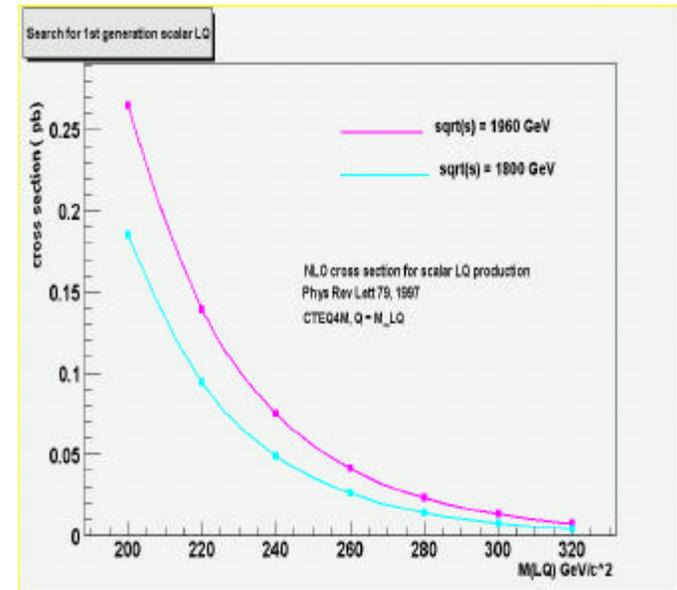
Code from Michael Kraemer (Phys.Rev.Lett 79,1997)

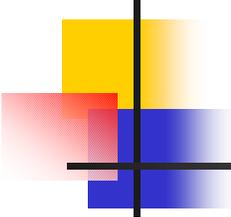
$M_{LQ}$ (GeV/c <sup>2</sup> )	$\sigma(\text{NLO})$ [pb]
200	0.185E+00
220	0.094E+00
240	0.489E-01
260	0.259E-01
280	0.138E-01
300	0.746E-02
320	0.401E-02

$M_{LQ}$ (GeV/c <sup>2</sup> )	$\sigma(\text{NLO})$ [pb]
200	0.265E+00
220	0.139E+00
240	0.749E-01
260	0.412E-01
280	0.229E-01
300	0.129E-01
320	0.727E-02

$\sqrt{s} = 1800$  GeV  
 $Q^2 = M_{LQ}^2$   
 CTEQ4M pdf

$\sqrt{s} = 1960$  GeV  
 $Q^2 = M_{LQ}^2$   
 CTEQ4M pdf





# Previous results from Run I

---

- Cdfnote 4228 - July 1997
  - $m(\text{LQ}) > 180 \text{ GeV}/c^2$
  - straightforward strategy
    - cut on transverse mass to get rid of  $W + 2 \text{ jets}$  background
  
- Cdfnote 4873 - June 2001
  - $m(\text{LQ}) > 182 \text{ GeV}/c^2$ 
    - relative likelihood technique

# LQ search in $evjj$

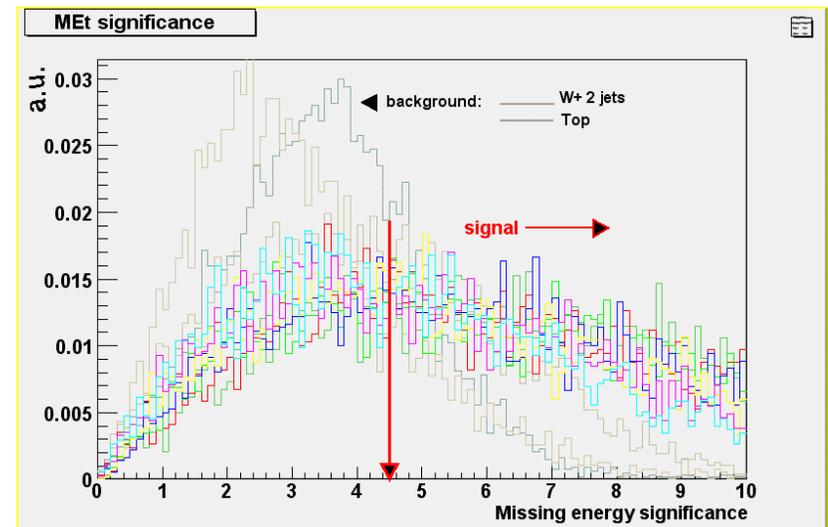
Signature: 1 electron, 2 jets and large MET

## Analysis cuts

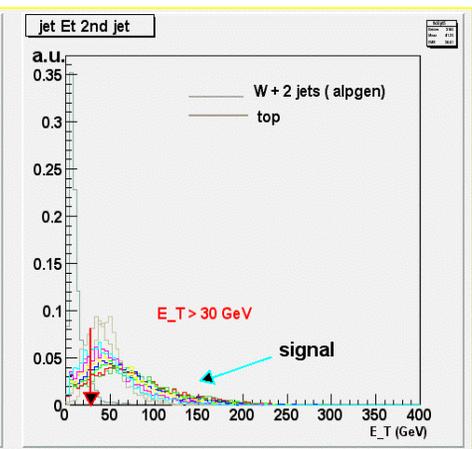
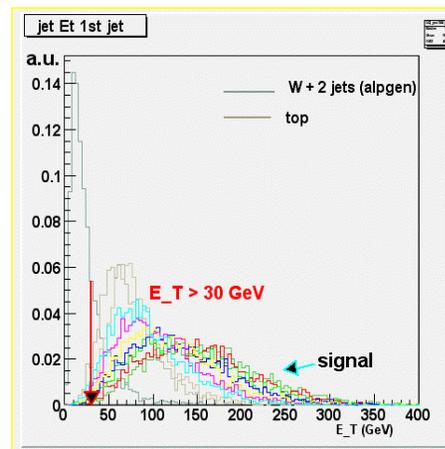
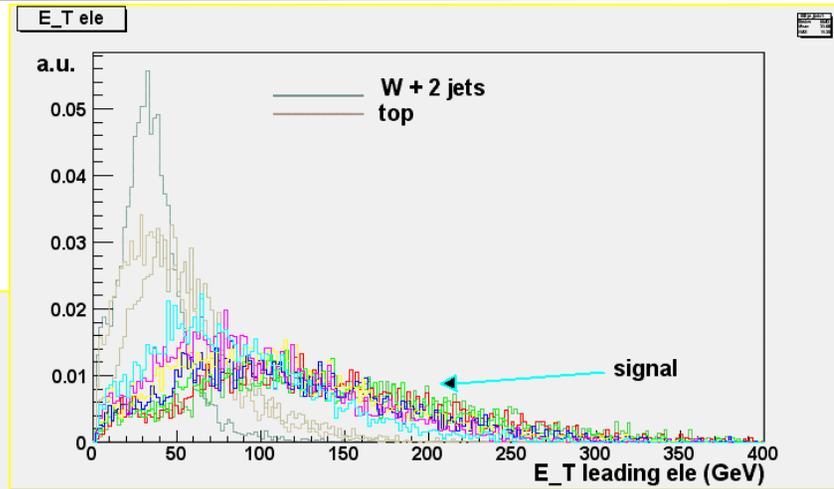
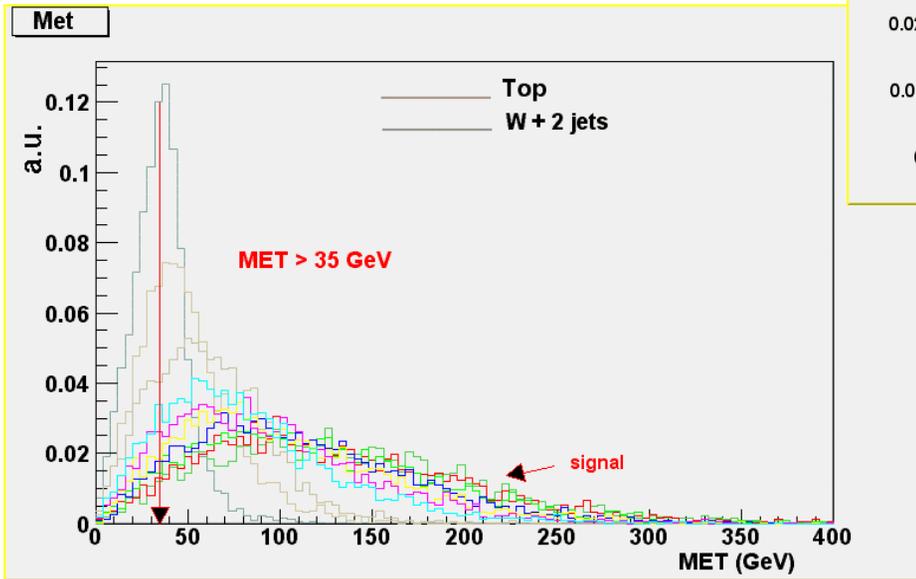
- 1 central electrons with  $E_T > 25$  GeV and  $MET > 35$  GeV
- 2 jets with  $E_T > 30$  GeV
- $\Delta\phi$  (MET-jet)  $> 10^\circ$
- $E_T(j1) + E_T(j2) > 80$  GeV
- $M_T(e-\nu) > 120$
- $Met/\sqrt{\Sigma E_T} > 4.5$

similar to note 4228, but for metSig cut

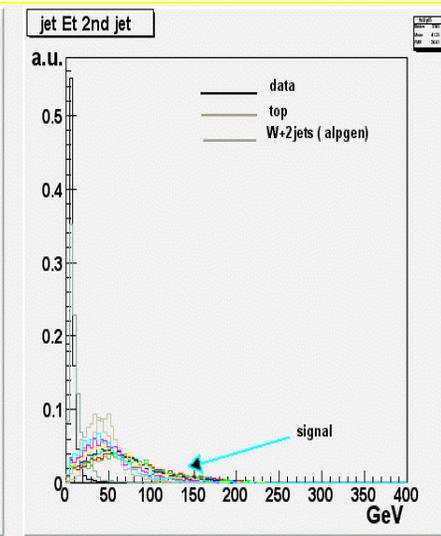
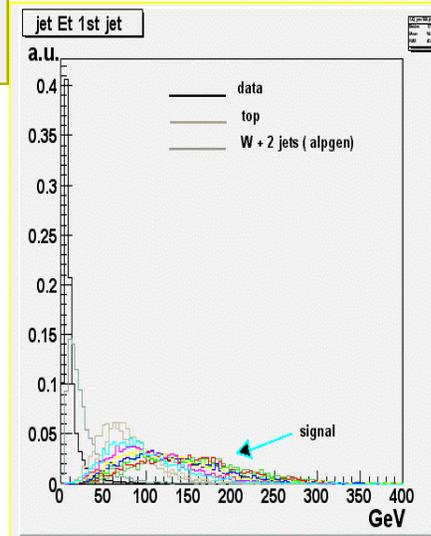
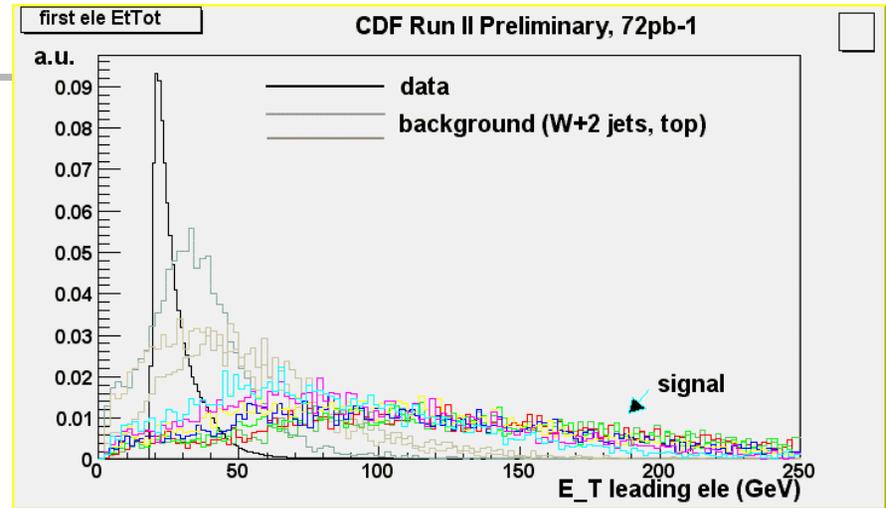
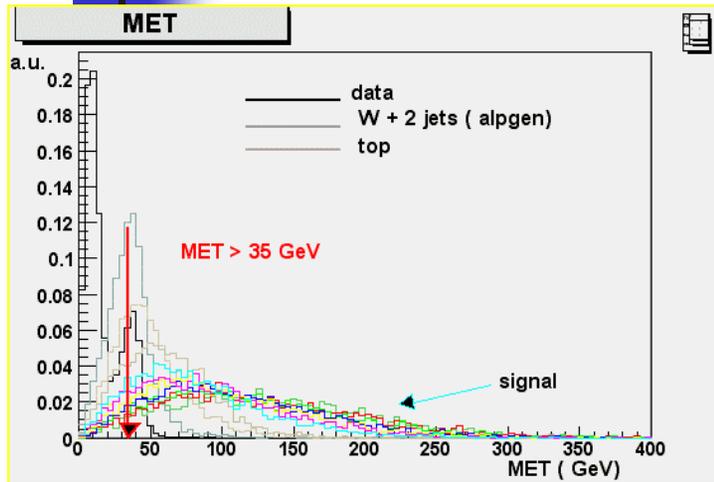
Events with 2 central electrons are rejected  
(to be orthogonal to  $eejj$  analysis)

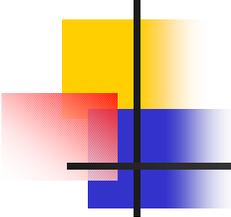


# MC distributions



# Comparison with data



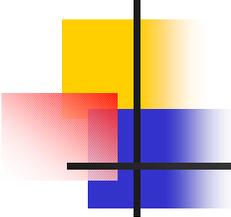


# Tools

---

- Signal generated and reprocessed with 4.9.1
  - 5000 events at masses from 160 to 280
    - run number 151435
    - full beam position
      - talk GenPrimVert
      - BeamlineFromDB set false
      - sigma\_x set 0.0025
      - sigma\_y set 0.0025
      - sigma\_z set 28.0
      - pv\_central\_x set -0.064
      - pv\_central\_y set 0.310
      - pv\_central\_z set 2.5
      - pv\_slope\_dxdz set -0.00021
      - pv\_slope\_dydz set 0.00031
      - exit
- eN ( 4.9.1)used for ntuple analysis
  - <http://ncdf70.fnal.gov:8001/talks/eN/eN.html>

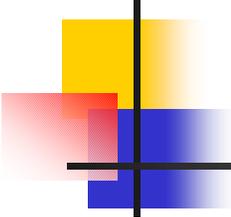
Same as cdf6338



# Efficiencies & acceptance

$$\epsilon_{\text{tot}} = \epsilon_{\text{Acc}}(M) \times \epsilon_{\text{ID}} \times \epsilon_{z_0} \times \epsilon_{\text{trig}}$$

- Trigger
  - Top/EW - as in  $Z'$  analysis we use  $99.1 \pm 0.1\%$
- Efficiencies for electron selection cuts
  - $Z'$  analysis
    - $\epsilon_T = 89.6 \pm 0.5$
- Other
  - efficiency on the vertex cut ( $|z_0| < 60 \text{ cm}$ )  $95.2 \pm 0.1$  (stat)  $\pm 0.5$  (sys) (Willis Sakumoto)



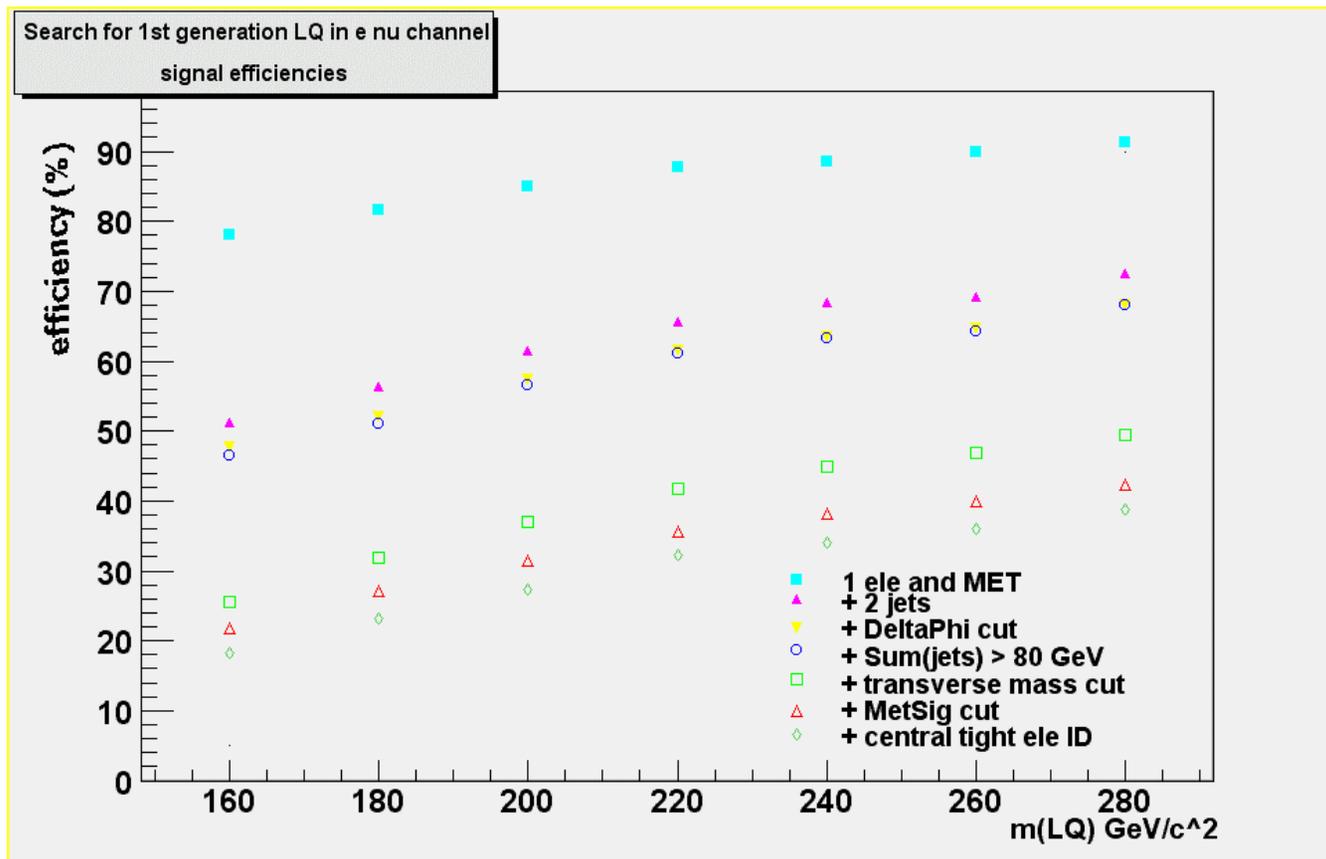
# Electron ID ( Z' analysis )

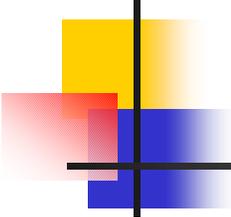
---

- Central electron ( loose or tight )
  - $E_t \geq 25$  GeV
  - $p_t > 10$  GeV
  - $\text{hadem} \leq 0.055 + 0.00045 * E$
  - $E/p < 4$  ( for  $E_T < 200$  GeV)
  - $\text{iso4e}/\text{emet} < 0.1$  ( 0.2 for second central loose)
  - $|\text{DeltaX}| < 3.0$
  - $|\text{DeltaZ}| < 5.0$  cm
  - Fiducial = 1
  - $\text{Ishr} < 0.2$

$$\epsilon_T = 86.2 \pm 0.5\%$$

# Total acceptance



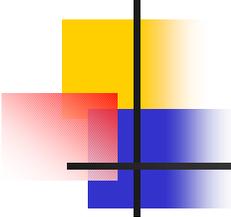


# Expected signal events

---

Number of expected events in  $72 \text{ pb}^{-1}$

Mass (GeV/c <sup>2</sup> )	n Theory CTEQ4M (pb)	n Theory CTEQ4M (pb)
	$Q^2 = M_{LO}^2/4$	$Q^2 = 4M_{LO}^2$
160	7.1	6.2
180	4.8	3.8
200	2.8	2.3
220	1.7	1.4
240	0.99	0.8
260	0.6	0.5
280	0.34	0.3

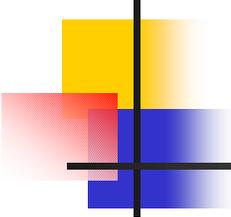


# Background

---

- tt with both W  $\rightarrow$  ev  $0.34 \pm 0.04$  events
  - pythia
- tt decaying into l + jets  $0.03 \pm 0.01$  events
  - pythia
- W + 2 jets
  - alpgen + PS  $5.13 \pm 4.0$  events

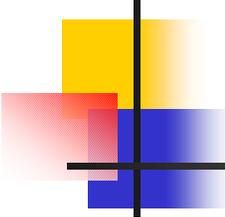
Total	$5.51 \pm 4.9$
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# Data sample

---

- btop0g (inclusive electrons) stripped from bhe108 and (4.8.4 Production)
- Inclusive-ele\_484\_REMAKE
- events selected from Ele\_18 && Ele\_70 triggers
- good runs from March 23 2002 to Jan 12 2003 (141544 - 156487)
- $70.2 \text{ pb}^{-1} \times 1.019$ 
  - 1 isolated electrons
    - One tight ( central)
  - MET > 35 GeV
  - At least 2 energetic jets



# Data sample

```
module clone Prereq HPTE
module enable Prereq-HPTE
module talk Prereq-HPTE
L1Accept set true
L2Accept set true
L3Accept set false
L3TriggerNames set ELECTRON70_L2_JET \
                    ELECTRON_CENTRAL_18 \
                    ELECTRON_CENTRAL_18_NO_L2 \
                    W_NOTRACK \
                    W_NOTRACK_NO_L2 \
                    Z_NOTRACK
debug set false
exit
exit
```

```
module clone StripSingleE HPE2
module enable StripSingleE-HPE2
module talk StripSingleE-HPE2
elePtMin set 15.0
etCalMin set 70.0
delXMin set 3.0
delZMin set 5.0
show
exit
```

```
module clone StripSingleE HPE1
module enable StripSingleE-HPE1
module talk StripSingleE-HPE1
elePtMin set 9.0
etCalMin set 18.0
delXMin set 3.0
delZMin set 5.0
EoPMax set 4.0
lshrMax set 0.3
hademMax set 0.125
show
```

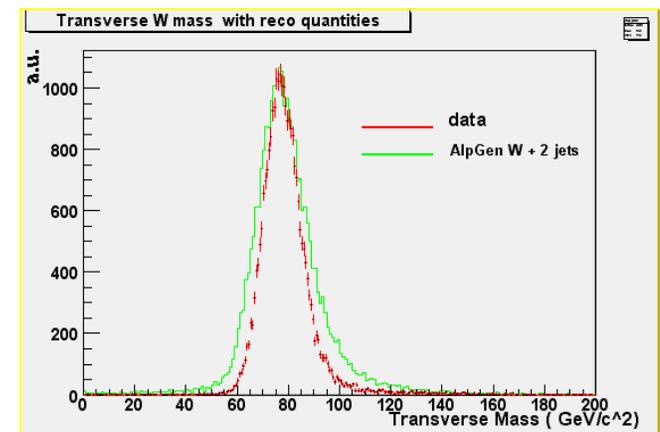
# W cross section

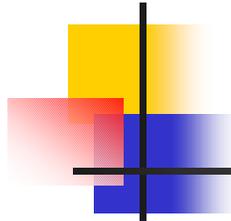
Relaxing the MET cut to 25 GeV we obtain 44510 candidate W events

Assuming the same background expectation as in CDF6300 (scaled to the increased Luminosity) we obtain:

$$\sigma\text{Br}(W \rightarrow e\nu) = (N_Z - N_{\text{BG}}) / (A_W \cdot e_{\text{ID}} \cdot e_{\text{trig}} \cdot e_{z_0} \cdot L) = 2.93 \pm 0.01 \text{ (stat)} \pm 0.13 \text{ (sys)} \pm 0.27 \text{ (lumi) nb}$$

Acceptance	24.6 ± 0.04 ± 1.05 (sys)%
ID efficiency	86.42 ± 0.5%
trigger efficiency	99.9 ± 0.1%
z <sub>0</sub> efficiency	95.2 ± 0.5%
Observed events	44510
estimated bkg	2590 ± 100 (stat) ± 900 (sys)
integrated L	72.0 ± 0.45



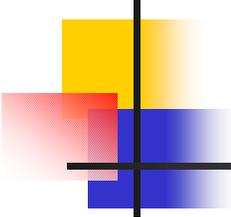


# Analysis results

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0 events survive the analysis cuts:

Number of events with 1 ele $> 25$ && MET $> 35$	26413
evt with 1 ele, MET and $\geq 2$ jets ( 30 30 )	224
evt with 1 ele, MET and $\geq 2$ jets and dphi cut	176
evt with 1 ele, MET and $\geq 2$ jets and dphi cut and 2jet_80	136
evt with 1 ele, MET and $\geq 2$ jets and dphi cut and 2jet_80 and T mass cut	23
evt with 1 ele, MET and $\geq 2$ jets and dphi cut and 2jet_80 and T mass cut and metsig 0	



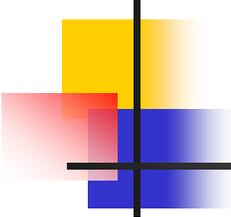
## Cross section LIMIT

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---

Mass	95%CL sigma ( pb)	$\sigma$ Theory CTEQ4M (pb)	
		$Q^2 = M^2/4$	$Q^2 = 4M^2$
160	0.2337	0.595	0.474
180	0.184152	0.2855	0.229
200	0.157208	0.144	0.1165
220	0.133053	0.0755	0.061
240	0.125625	0.0407	0.03285
260	0.119176	0.0225	0.018
280	0.110681	0.01255	0.01

---



# Number of events limit

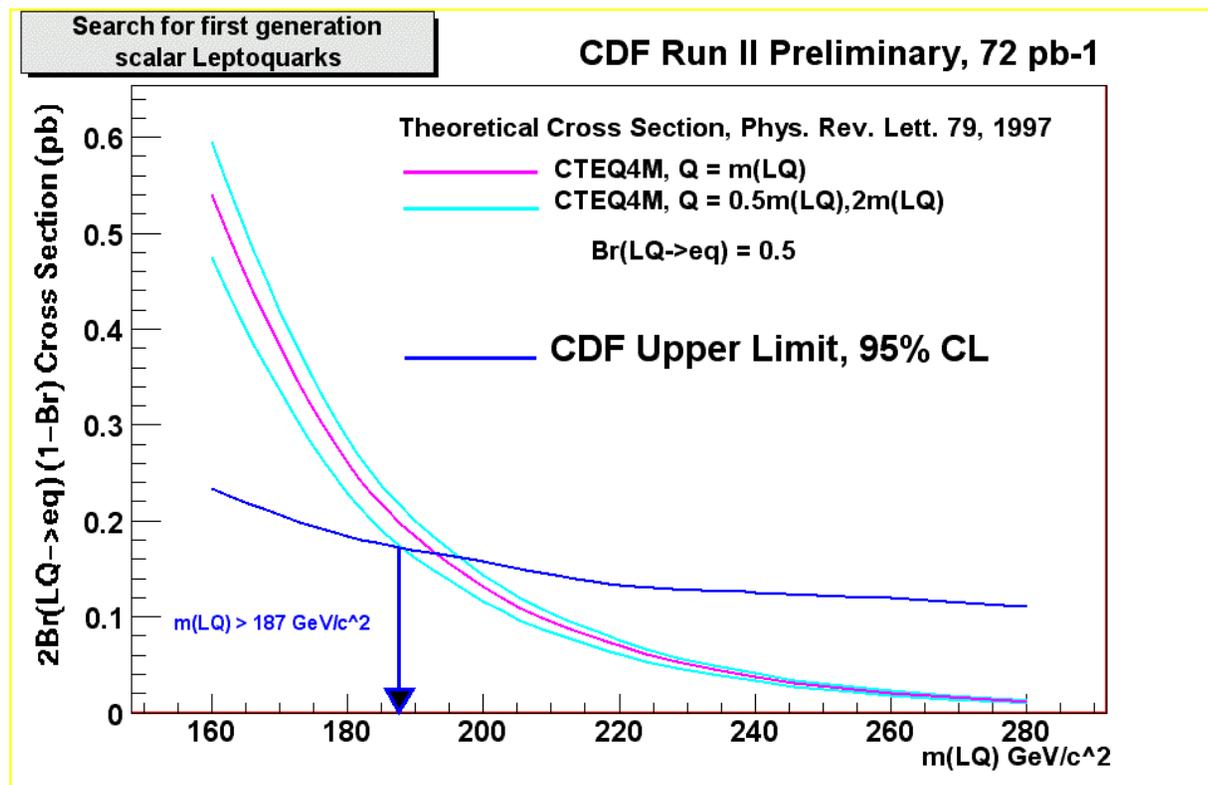
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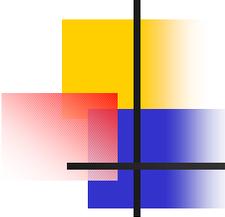
Mass	95%CL nev ( pb)	N Theory CTEQ4M (pb)	
		$Q^2 = M^2/4$	$Q^2 = 4M^2$
160	3.067	7.80	6.22
180	3.067	4.75	3.83
200	3.067	2.80	2.27
220	3.067	1.74	1.40
240	3.067	0.99	0.80
260	3.067	0.57	0.46
280	3.067	0.35	0.27

---

# Cross section Limit



$M_{\text{LQ}} > 187 \text{ GeV @ 95\% CL}$

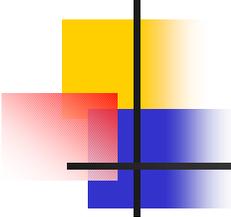


# Systematic uncertainties

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- Luminosity: 6%
- Acceptance
  - pdf 4.3% ( from run I )
  - statistical error of MC 2.2%
  - jet energy scale ( Level 3) 2.9 - 0.7 % ( absolute uncertainty)
    - jets corrected for energy scale, time dependent and relative response
    - jet energy scaled of systematic uncertainty + 5% ( energy scale + 5% data/MC adjustment);
- Electron ID efficiency ( $Z'$ )
  - statistical error of  $Z \rightarrow e^+e^-$  sample: 0.8%
  - energy scale : 3.7%
- Event vertex cut : 0.5% ( Willis )

Final relative  
uncertainty on  
acceptance 9%



# Conclusions

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- A preliminary 95% CL cross section lower limit as a function of  $M_{LQ}$ , for leptoquarks decaying with 100% branching ratio into eq ( $\beta = 0.5$ ) has been set.
- Comparing it to the NLO theoretical predictions for leptoquark pairs production at the TeVatron, an upper limit on the Leptoquark mass is obtained at

$$m_{LQ} > 187 \text{ GeV}/c^2$$

- consistent with run I limit at  $182 \text{ GeV}/c^2$